

TRANSLATION

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Tokyo, Japan, state:

that I know well both the Japanese and English languages,  
that I translated, from Japanese into English, Japanese Patent  
Application No. 2001-129035, filed on April 26, 2001, and  
that the attached English translation is a true and accurate  
translation to the best of my knowledge and belief.

Dated: May 15, 2006



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[Name of Document] PATENT APPLICATION

[Reference Number] 200100685

[Filing Date] April 26, 2001

[To] Commissioner, Patent Office

[International Patent Classification] G21C 3/02

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[Indication of Official Fee]

[Prepayment Register  
Number] 000181

[Amount of Payment] ¥21,000

[List of Items Submitted]

[Name of Item]	Specification	1
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[Name of Item]	Drawing	1
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[Name of Item]	Abstract	1
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[Necessity of Proof] Necessary



- 1 -

[Document]

SPECIFICATION

[Title of the Invention] THIMBLE SCREW FOR FUEL ASSEMBLY

[What is claimed is:]

[Claim 1] A thimble screw for a fuel assembly, which is provided in a lower nozzle of the fuel assembly of a nuclear reactor so as to extend from a bottom surface side, has a hole part extending internally in a longitudinal direction from a counter poring hole of a seat part to a drain hole of a top end part, is constructed so as to flow a coolant in a direction from the counter poring hole of the seat part toward the drain hole of the top end part during operation of the nuclear reactor and flow the coolant in a direction from the drain hole toward the counter poring hole of the seat part during scrambling, and is prevented from loosening at the lower nozzle by a rotation stopper pin in the seat part, characterized in that a water receiving machined portion for increasing pressure loss of the coolant during the scrambling is provided in a side of the hole part of the rotation stopper pin.

[Claim 2] A thimble screw for a fuel assembly, which is provided in a lower nozzle of the fuel assembly of a nuclear reactor so as to extend from a bottom surface side, has a drain hole extending internally in a longitudinal direction from a counter poring hole of a seat part to a hole part of a top end part, is constructed so as to flow a coolant in a direction from the counter poring hole of the seat part toward the hole part of the top end part during operation of

the nuclear reactor and flow the coolant in a direction from the hole part toward the counter boring hole of the seat part during scrambling, and is prevented from loosening at the lower nozzle by a rotation stopper pin in the seat part, characterized in that an opening area of the drain hole is set smaller than an opening area of the counter boring hole and than an opening area of the hole part.

[Claim 3] The thimble screw for the fuel assembly, according to claim 2, characterized in that a water receiving machined portion for increasing pressure loss of the coolant during the scrambling is provided in a side of the hole part of the rotation stopper pin.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a thimble screw for a fuel assembly used in a nuclear reactor.

[0002]

[Prior Art]

FIG. 5 is a structural view schematically showing the structure of a conventional fuel assembly.

FIG. 6(a) is an enlarged sectional view showing part of a conventional fuel assembly, and FIG. 6(b) is a bottom view of a main part shown in FIG. 6(a).

[0003]

As shown in FIG. 5, a fuel assembly 30 has upper and lower nozzles 32 and 33 at upper and lower ends of elongated

guide thimbles 31, and an upper support grid 34, middle support grids 35, and lower support grid 36 fixed over the longitudinal direction thereof the guide thimbles 2. Each of the support grids 34 to 36 is formed from a large number of lattice frames using thin plates, and are arranged so as to hold fuel rods 37.

[0004]

As shown in FIGS. 6(a) and 6(b), the guide thimble is welded to a thimble end plug 38, and fixed to the lower nozzle 33 by a thimble screw 40 through an insert 39. The lower support grid 36 is fixed to an upper part of the insert 39. A drain hole 41 penetrates through the thimble screw 40, and further, a seat part 42 thereof is provided with a rotation stopper pin 43 for stopping loosening of the thimble screw 40.

[0005]

Also, the seat part 42 is provided with a counter boring hole, which communicates with a lower part of the drain hole 41 and reaches the bottom surface of the seat part 42.

In addition, by reducing the hole diameter of the drain hole 41, the fall velocity of a control rod not shown which is dropped from the side of the top end 40A of the thimble screw 40 at the time of scrambling is decelerated before the control rod is completely inserted.

[0006]

[Object of the Invention]

Since the thimble screws in the conventional fuel

assembly are constructed as described above, there have been a problem as follows. That is, the drain hole 41 serves to ensure the cooling characteristic of NFBC (non fuel bearing components) to be inserted in guide thimbles, so the hole diameter at the top end is reduced. This can be achieved together with the deceleration effect as described above.

[0007]

The present invention has been made to solve the above problem and particularly has an object of providing thimble screws for a fuel assembly, which can achieve both the deceleration effect of the fall velocity of the control rods to be inserted at the time of scrambling and the NFBC.

[0008]

[Means for Achieving the Object]

A thimble screw for a fuel assembly, according to the present invention, has a structure which is provided in a lower nozzle of the fuel assembly of a nuclear reactor so as to extend from a bottom surface side, has a hole part extending internally in a longitudinal direction from a counter boring hole of a seat part to a drain hole of a top end part, is constructed so as to flow a coolant in a direction from the counter boring hole of the seat part toward the drain hole of the top end part during operation of the nuclear reactor and flow the coolant in a direction from the drain hole toward the counter boring hole of the seat part during scrambling, and is prevented from loosening at the lower nozzle by a rotation stopper pin in the seat part, wherein

that a water receiving machined portion for increasing pressure loss of the coolant during the scrambling is provided in a side of the hole part of the rotation stopper pin. In addition, a thimble screw for a fuel assembly, according to another embodiment of the present invention, has a structure which is provided in a lower nozzle of the fuel assembly of a nuclear reactor so as to extend from a bottom surface side, has a drain hole extending internally in a longitudinal direction from a counter boring hole of a seat part to a hole part of a top end part, is constructed so as to flow a coolant in a direction from the counter boring hole of the seat part toward the hole part of the top end part during operation of the nuclear reactor and flow the coolant in a direction from the hole part toward the counter boring hole of the seat part during scrambling, and is prevented from loosening at the lower nozzle by a rotation stopper pin in the seat part, wherein an opening area of the drain hole is set smaller than an opening area of the counter boring hole and than an opening area of the hole part, and a water receiving machined portion for increasing pressure loss of the coolant during the scrambling is provided in a side of the hole part of the rotation stopper pin.

[0009]

[Embodiment of the Invention]

A preferred embodiment of a thimble screw for a fuel assembly according to the present invention will be explained with the drawings.



The parts which are the same or equivalent to those in the conventional apparatus are referred to at identical reference symbols, and explanation thereof will be omitted.

[0010]

Embodiment 1.

FIG. 1 is a structural view showing a state in which a rotation stopper pin 2 for a thimble screw in a fuel assembly according to the present invention is built into the thimble screw 1. FIG. 2 is a structural view showing a rotation stopper pin for a thimble screw in the fuel assembly according to the embodiment 1 of the present invention.

[0011]

As shown in FIG. 1, at a shaft part 6 of the thimble screw 1, there is provided a guide hole 7 as a hole extending from a counter boring hole 4 of a seat part 1A to a drain hole 3 on the top end side in the longitudinal direction of the thimble screw 1.

With the rotation stopper pin 2 being mounted in the counter boring hole 4, during operation of the nuclear reactor, a coolant enters from the counter boring hole 4 of the seat part 1A (in the direction indicated by an arrow A) and is drained from a top end 11 of the top end 11 of the drain hole 3. Meanwhile, when the control rod is dropped at the time of scrambling, the coolant enters from the top end 11 of the drain hole 3 (in the direction of an arrow F) and is drained from the counter boring hole 4 of the seat part 1A.

[0012]

In the thimble screw 1 of the fuel assembly according to the embodiment 1 of the present invention, the rotation stopper pin 2 has, at its upper side (the side of the guide hole 7), a water receiving machined portion 26 formed of a recess with an arcuate section, so it receives the flow of the coolant passing through the guide hole 7 in the direction indicated by the arrow F. The water receiving machined portion 5 increases the pressure loss of the coolant flowing in the direction of the arrow F.

[0013]

FIGS. 1 and 2(c) show an arcuate machined portion 12 formed of a recess with an arcuate section as a typical example of the rotation stopper pin 2 with the water receiving machined portion 5. Alternatively, the water receiving machined portion 5 may be a V-shaped machined portion 8 with a V-shaped section (as shown in FIG. 2(a)), or a flat machined portion 9 (as shown in FIG. 2(b)). This water receiving machined portion 5 can have any shape as far as it can increase the pressure loss in the direction of the arrow F against the flow of the coolant passing through the guide hole 7 in the direction of the arrow F, when compared with a conventional case wherein a rotation stopper pin without a water receiving machined portion is used.

[0014]

With the structure of the conventional rotation stopper pin, the ratio of the pressure loss coefficient for the flow

of the coolant entering from the counter poring hole 4 of the seat part 1A and draining from the top end 11 of the drain hole 3 (the flow in the direction of the arrow A), to the pressure loss coefficient of the flow of the coolant entering from the drain hole top end 11 and draining from the counter poring hole 4 of the seat part 1A (the flow in the direction of the arrow F), in the opposite manner, is almost 1 : 1.

[0015]

However, the thimble screw 1 of the fuel assembly according to the embodiment 1 of the present invention comprises the rotation stopper pin 2 constructed as described above. Thus, the ratio of the pressure loss coefficient of the flow of the coolant entering from the counter poring hole 4 of the seat part 1A and draining from the top end 11 of the drain hole 3 (the flow in the direction of the arrow A), to the pressure loss coefficient of the flow of the coolant entering from the top end 11 of the drain hole 3 and draining from the counter poring hole 4 of the seat part 1A (the flow in the direction of the arrow F), in the opposite manner, can be raised to the range of 1 : 2 to 1 : 3.

[0016]

In the above, with the thimble screw 1 of the fuel assembly according to the embodiment 1 of the present invention, the rotation stopper pin 2 with the shape as described above is used, so that the thimble screw 1 can be let have a diode function. Thus, while maintaining the same cooling ability of the NFBC as that of the conventional, which

is caused by the flow of the coolant in the direction of the arrow A, the decelerating effect of the control rod can be improved by the increase in fluid resistance against the flow in the direction of the arrow F.

[0017]

Embodiment 2.

FIGS. 3 and 4 are structural views each showing a thimble screw in a fuel assembly according to the embodiment 2 of the present invention.

In a thimble screw for the fuel assembly according to the embodiment 2 of the present invention, a guide hole 27 is provided in the side of a top end 20A of the thimble screw 20, and a drain hole 23 is arranged in the side of the seat part 21 of the thimble screw 20.

[0018]

In FIG. 3, a shaft part 26 of the thimble screw 20 is provided with the drain hole 23 so as to penetrate between the guide hole 27 and a counter boring hole 24 of the seat part 21. The opening area of the drain hole 23 is set smaller than the opening area of the guide hole 27 and the opening area of the counter boring hole 24.

With a rotation stopper pin 22 being mounted in the counter boring hole 24, during operation of the nuclear reactor, a coolant enters from the counter boring hole 24 of the seat part 21 in the direction of an arrow A and is drained from a guide hole top end 25.

[0019]

Meanwhile, when a control rod is dropped at the time of scrambling, the coolant flows in the direction of an arrow F and enters from the guide hole top end 25 to flow through the counter boring hole 24 of the seat part 21. After passing through the drain hole 23, the coolant jets out toward the rotation stopper pin 17 as the flow path area is abruptly increased by the counter boring hole 24 of the seat part 16.

With this arrangement, when the control rod is dropped in the scram mode and the coolant enters from the top end 11 of the drain hole in the direction of the arrow F, the rotation stopper pin 22 functions strongly as the fluid resistance against the jet. Thus, the pressure loss against the flow of the coolant in the direction of the arrow F can be increased, and the decelerating effect of the control rod can be improved.

[0020]

In the thimble screw of the fuel assembly shown in FIG. 4, the rotation stopper pin 28 with the water receiving machined portion in the thimble screw for the fuel assembly according to the embodiment 1 is combined with the thimble screw 20 with the arrangement shown in FIG. 8.

This rotation stopper pin 28 is provided with a water receiving machined portion 29, like the rotation stopper pin of the embodiment 1.

[0021]

Thus, since the thimble screw of the fuel assembly according to the embodiment 2 of the present invention

is structured as described above, the coolant enters from the guide hole top end 25 in the direction of the arrow F and is discharged in the form of a jet from the drain hole 23 toward the rotation stopper pin 22. As the rotation stopper pin 22 strongly functions as a fluid resistance against the jet, the pressure loss for the flow of the coolant in the direction of the arrow F can be increased, and the decelerating effect of the control rod can be improved. Meanwhile, no influence is made on the flow rate resistance of the coolant in the direction of the arrow A. Thus, the coolant flow rate is assured, and the cooling ability of the NFBC can maintain the same effect as that of the conventional case.

[0022]

Further, when the rotation stopper pin 28 with the water receiving machined portion 29 is combined with a thimble screw in which the opening area of the drain hole 23 is set smaller than the opening area of the guide hole 27 and the opening area of the counter boring hole 24, like the thimble screw 14 of the fuel assembly shown in FIG. 4, the difference in pressure loss of the flow in the directions of the arrow A and F further increases. Therefore, a thimble screw for a fuel assembly with a better diode performance can be provided.

[0023]

[Advantages of the Invention]

According to the thimble screw for a fuel assembly of the present invention, the thimble screw can have a diode function.

Therefore, when a coolant is flowed from a counter poring hole of a seat part in the direction toward a hole part at a top end part or a drain hole, the same cooling characteristic of the NFBC based on the coolant flow as that of the prior art can be maintained. When the coolant is flowed from the hole part or drain hole in the direction toward the counter poring hole of the seat part, the liquid resistance can be increased to improve the deceleration effect of the control rod.

[Brief Description of the Drawings]

[FIG. 1]

A structural view showing a state in which a rotation stopper pin is assembled in a thimble screw for a fuel assembly according to the present invention.

[FIG. 2]

A structural view showing the rotation stopper pin in the thimble screw for the fuel assembly according to the embodiment 1 of the present invention.

[FIG. 3]

A structural view showing a thimble screw for a fuel assembly according to the embodiment 2 of the present invention.

[FIG. 4]

A structural view showing the thimble screw for the fuel assembly according to the embodiment 2 of the present invention.

[FIG. 5]

A structural view schematically showing the structure of

a conventional fuel assembly.

[FIG. 6]

(a) is an enlarged cross-sectional view showing a main part of a conventional fuel assembly, and (b) is a bottom view of the main part shown in (a).

[Explanation of Reference Symbols]

- 1, 20 ... Thimble screw
- 1A, 21 ... Seat part
- 2, 22, 28 ... Rotation stopper pin
- 3 ... Drain hole
- 4 ... Counter boring hole
- 5, 29 ... Water receiving machined portion
- 6, 26 ... Shaft part
- 7, 27 ... Guide hole
- 8 ... V-shaped machined portion
- 9 ... Flat machined portion
- 11, 25 ... Top end
- 12 ... Arcuate machined portion
- 20A ... Top end side
- 23 ... Drain hole
- 24 ... Counter boring hole

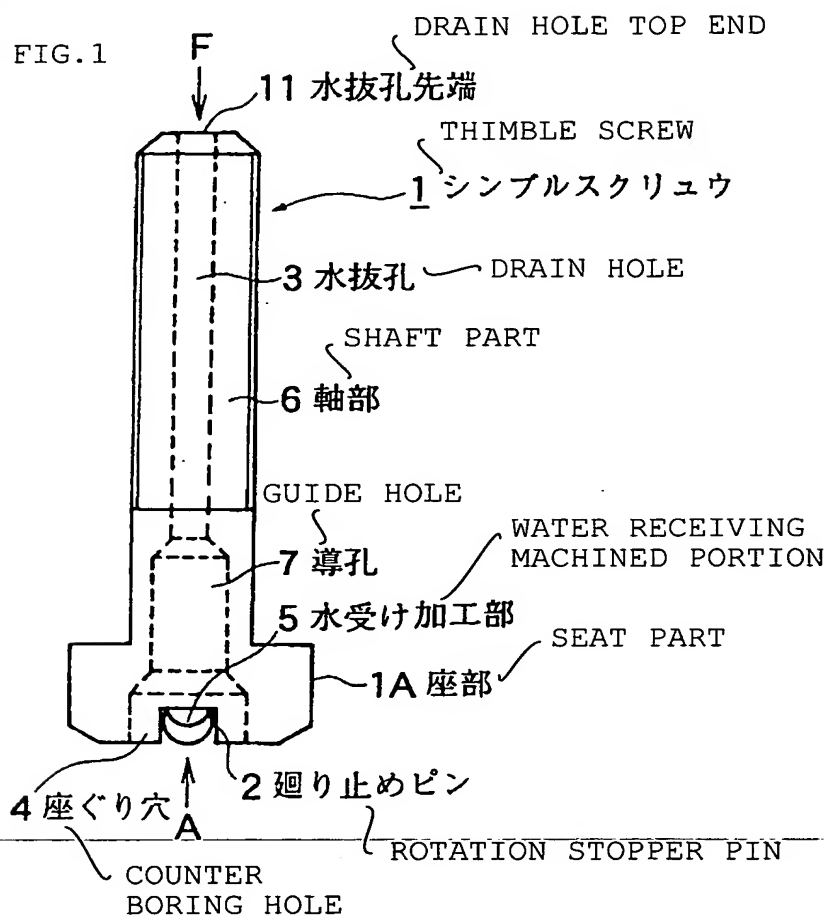


DOCUMENT

【書類名】 図面 FIGURE

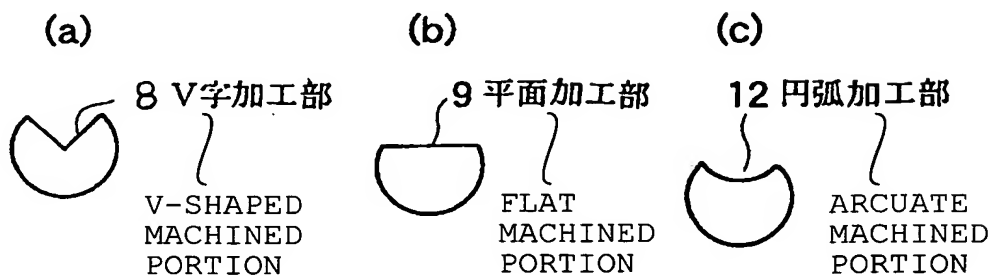
【図1】

FIG.1

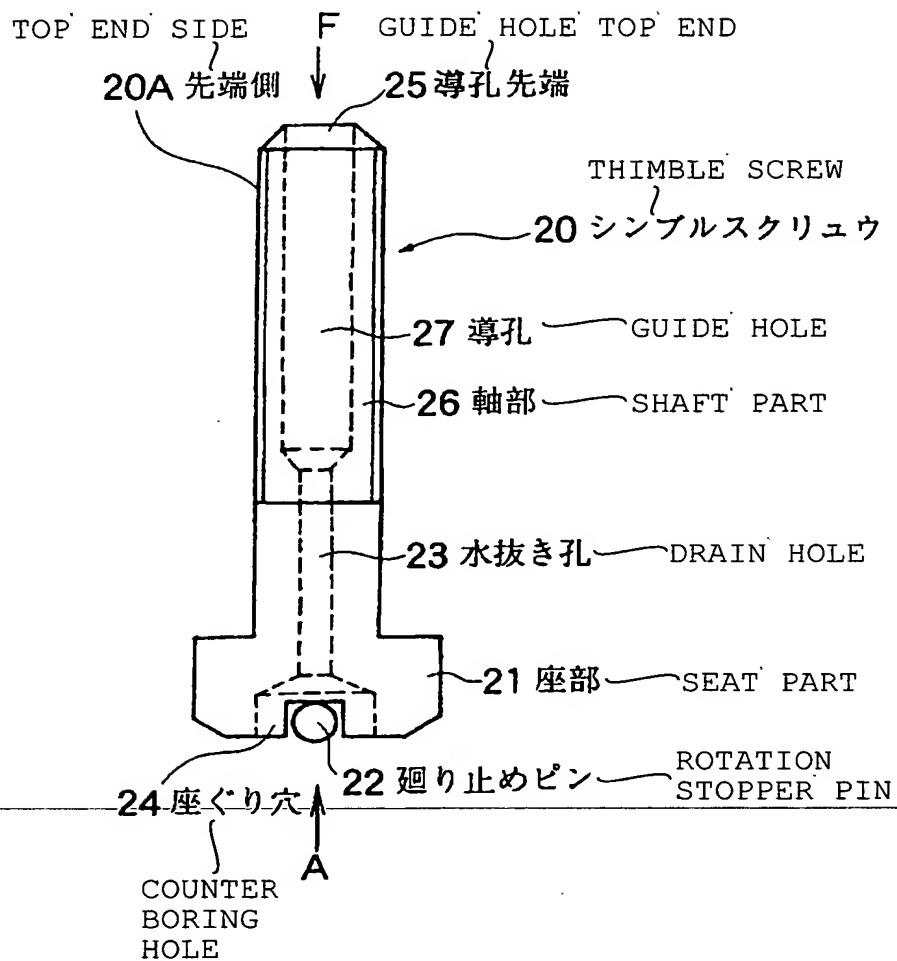


【図2】

FIG.2



【図3】  
FIG. 3



【図4】

FIG. 4

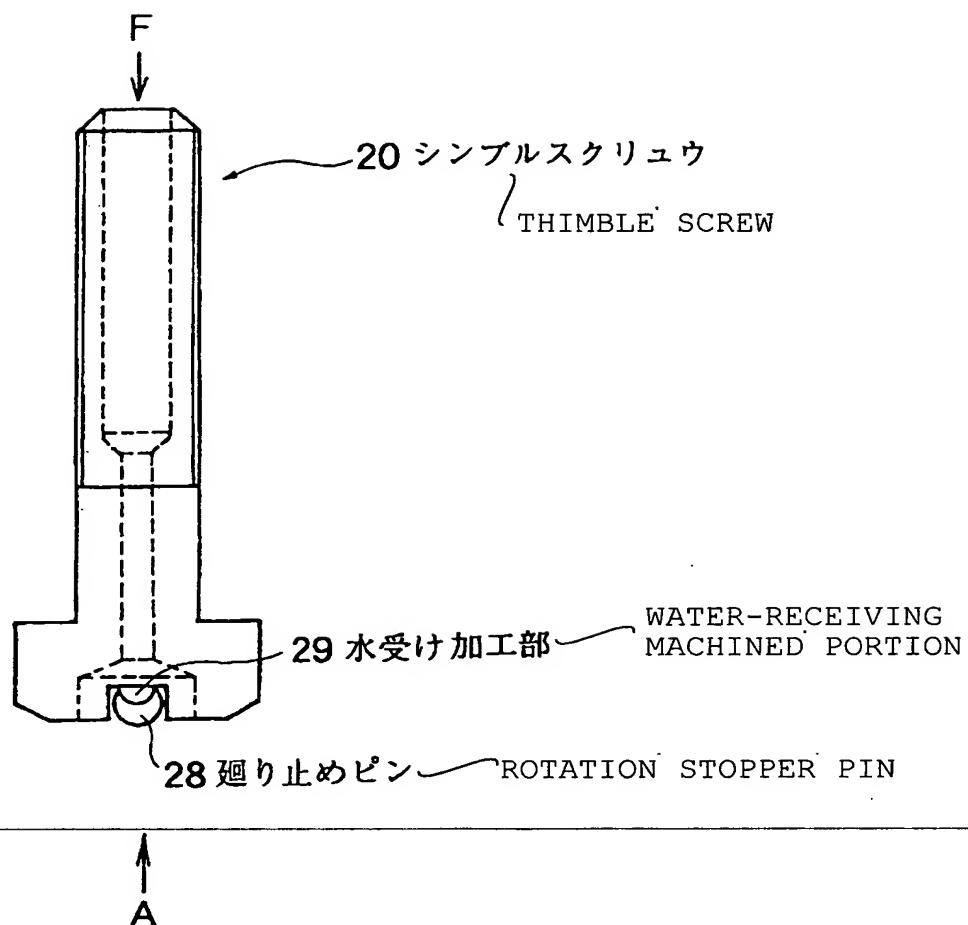


FIG. 5  
【図5】

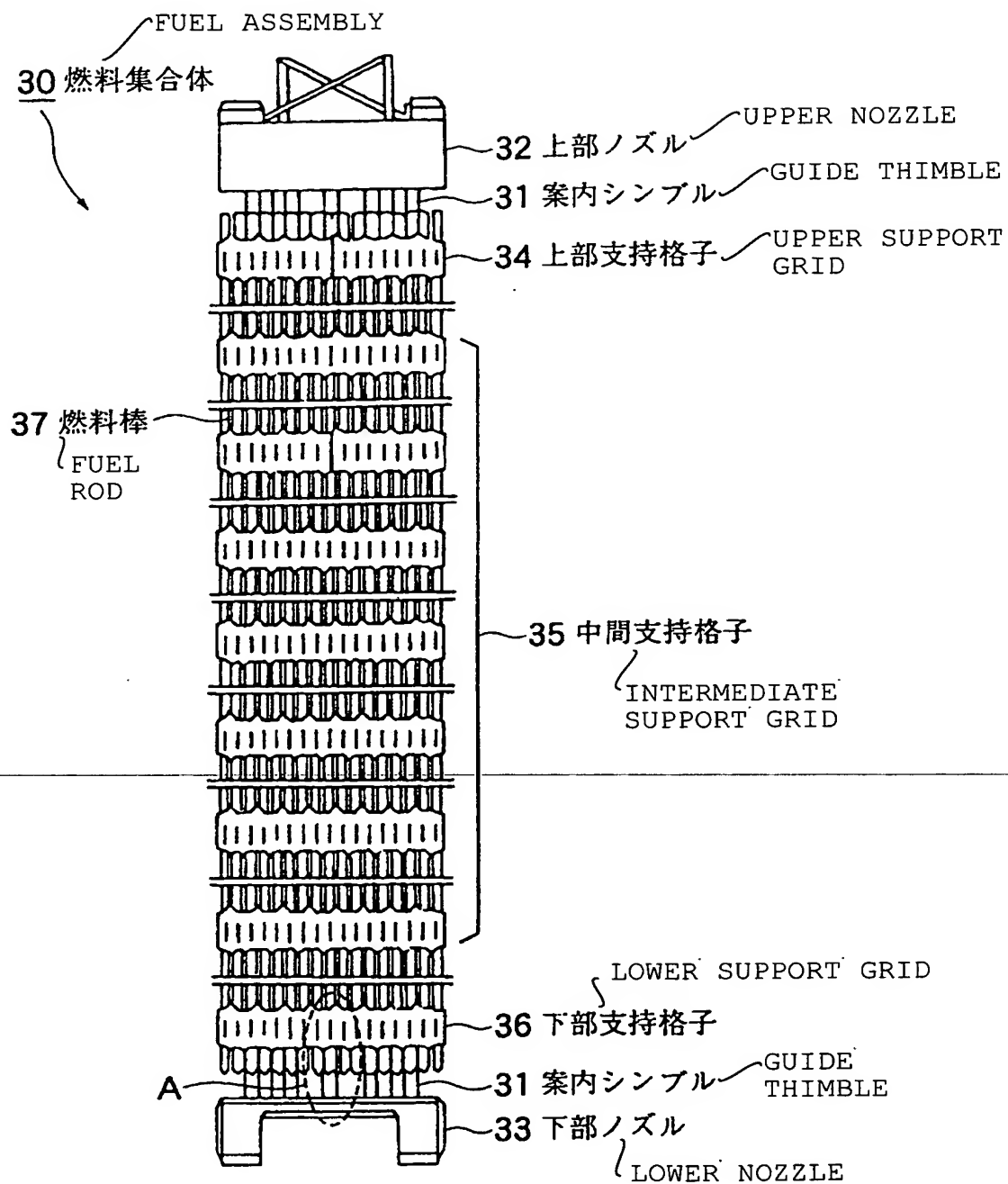
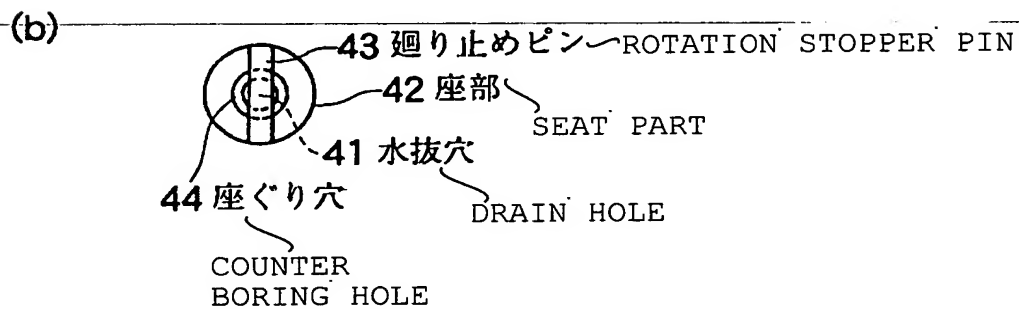
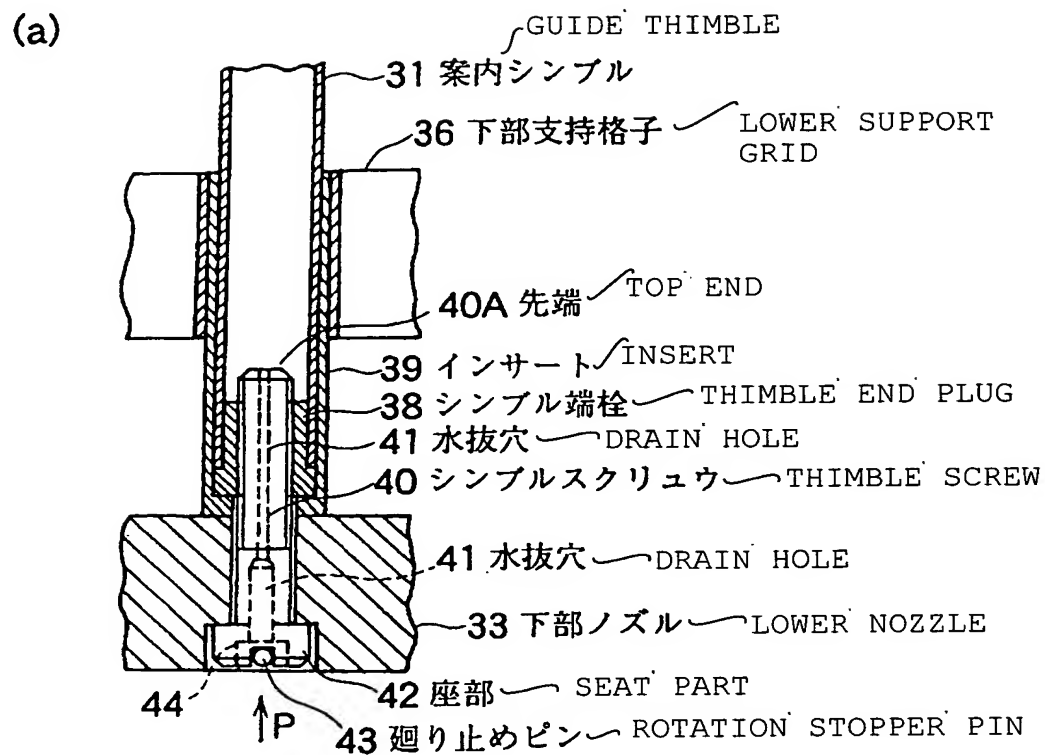


FIG. 6  
【図6】



[Document]        Abstract

[Abstract]

[Object]    An object is to provide a thimble screw for a fuel assembly which can achieve both deceleration effect on the fall velocity of a control rod to be inserted at the time of scramming and cooling performance of NFBC.

[Means for Achieving the Object]    A thimble screw for a fuel assembly according to the present invention is constructed so as to flow a coolant in a direction from the counter poring hole of the seat part toward the drain hole of the top end part during operation of the nuclear reactor and flow the coolant in a direction from the drain hole toward the counter poring hole of the seat part during scramming, and is prevented from loosening at the lower nozzle by a rotation stopper pin in the seat part, wherein a water receiving machined portion for increasing pressure loss of the coolant during the scramming is provided in a side of the hole part of the rotation stopper pin.

[Elected Figure]        FIG. 1